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AIR POLLUTION: FIRST FOLLOW-UP REPORT. AIR POLLUTION PILOT STUDY

NATO Committee on the Challenges of Modern Society
Brussels, Belgium

19 September 1975

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COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY

NATO OTAN

AIR POLLUTION

FIRST [illegible] REPORT

PILOT STUDY

POLLUTION ATMOSPHÉRIQUE

PREMIER RAPPORT SUR LES PROJETS AU STADE PILOTE

DE LA CCMS SUR LA POLLUTION ATMOSPHÉRIQUE

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AIR POLLUTION PILOT STUDY FOLLOW-UP REPORT

First Report

September 19, 1975

Prepared by

United States of America
as ex-Pilot of the Study

NATO Committee

on the

Challenges of Modern Society

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EXECUTIVE SUMMARY:

FIRST AIR POLLUTION PILOT STUDY FOLLOW-UP REPORT

The first follow-up report on the 15 Air Pollution Pilot Study Recommendations is to concentrate on the status of NAC NATO/CCMS Recommendations I, II, III, IV, V, VII, VIII and XIV in cities with populations over 600,000, and will serve as baseline information against which progress can be measured. The Recommendations include general assessment of air pollution, standard-setting, establishment of air quality monitoring systems and suitable systems for retrieval and storage of data, employment of recognized reference methods for monitoring and institution of uniform procedures for conducting emissions inventories.

Responsiveness

The survey included 51 cities with populations over 600,000 and the capitals of the three nations with no cities over 600,000. At the time of final printing of this report, responses had been received for 44 of the 54 cities.

A total of ten nations submitted completed questionnaires for all cities in the survey. Three nations completed questionnaires for

half of their survey cities. Two nations submitted publications and letters in lieu of questionnaires. No response was reported for one nation.

STANDARDS AND CONTROL APPROACHES

A basic difference in the approaches and objectives of national air pollution programs involves ambient standards. Some nations place primary emphasis on the quality of ambient air, while others concentrate on standards set for specific categories of emission sources. One city reported a scheme in which desired ambient concentrations were set for various industrial sectors and emission control levels within those sectors adjusted to achieve the desired ambient concentrations.

This city was the only instance in which emission control levels were set within a single city for the purpose of achieving locally-set standards. This approach very closely approximates the CCMS-endorsed concept of relating emission control programs directly to desired ambient air quality in a cohesive air quality management system. There is a need for considerable work in this area, as only five countries have established ambient air quality standards. Four nations have set emission standards without basing them on ambient standards, and five nations reported no standards at all.

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The first follow-up report on the 15 Air Pollution Pilot Study Recommendations is to concentrate on the status of NAC NATO/CCMS Recommendations I, II, III, IV, V, VII,& VII & XIV in cities with populations over 600,000, and will serve as baseline information against which progress can be measured. The Recommendations include general assessment of air pollution, standard-setting, establishment of air quality monitoring systems and suitable systems for retrieval and storage of data, employment of recognized reference methods for monitoring and instituttion of uniform procedures for conducting emissions inventories.

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AMBIENT MONITORING

Objectives

The objectives of current monitoring systems were ranked to provide a reference point for evaluation of the effectiveness of systems. Two nations reported high priority for the objective of assessing compliance with ambient air quality standards and yet reported having no health-related standards. The five nations with ambient standards reported assessment of compliance as the first priority objective. Validation of dispersion models has a uniformly low priority. Other priorities are highly variable from country to country.

Instrumentation

All responding nations have monitoring sites. All but two of these nations reported having automated or semi-automated sites. Only two nations lacked meteorological instruments. Only three cities reported no automatic instruments, and nine cities reported at least half of their instruments automated. Basic difference in monitoring techniques and strategies result in wide variations of the number of monitoring sites in cities. Several cities employ mobile monitoring units and consider each location sampled to be an individual site. Some arrangements include as many as four monitors distributed vertically on a tall structure.

Ambient Monitoring Statistics

The reporting of ambient monitoring statistics in the responses was quite limited. Only three nations with a standard for TSP reported monitoring data for that pollutant. Only four nations with standards for SO_2 reported statistics for SO_2. Of the four nations reporting statistics for CO, only three reported standards. Only two nations reported data for oxidants although they both have standards. It is evident that the monitoring statistics reported are sufficient only to assess the success of nations in meeting their own standards and not for making any comparisons.

There were four nations (seven cities) listing dates for which data are available but without supplying the data. Since all reporting cities have monitoring programs, this indicates that accessibility of existing data within a reasonable time and in a variety of forms may be a problem.

ANALYSIS OF AMBIENT AIR QUALITY TRENDS

A total of 70 analyses of ambient air quality trends were reported. There were seven responding cities with no trend analyses reported and an equal number reporting analyses for only a single pollutant. The trend analyses were predominantly for SO_2 and TSP, but some analyses of trends for carbon monoxide (CO), oxidants (O_x), nitrogen oxides (NO_x) and fluorides (F) were also available. The

average length of monitoring period for trend analysis was eight years. More than half of the analyses were based on monitoring data exclusively from years prior to 1972, and several analyses were apparently based on data from just one year.

Forty-nine cases of improving air quality (decreasing ambient concentration) and 18 cases of stable air quality were reported; there were two reported instances of quality declining over the entire analysis period for any pollutant surveyed.

The availability of more recent data in a number of cities indicates that some cities are developing data bases that will permit increased trend analysis. Increased emphasis on trends is in line with fairly high priorities given to trend analysis by some nations in ranking objectives for the monitoring program.

ATMOSPHERIC DISPERSION MODELING

Ten nations reported some modeling activity. Forty-seven instances of modeling were reported, all but nine being for TSP or SO_2. Twelve cities had no models, and 4 had modeled only one pollutant. Most models (36) were Gaussian rather than numerical (14). Three-quarters of the models had planning as one of their purposes, eleven were also used for regulatory purposes, and only five for research. Except for large groups of TSP and SO_2 models, unreported

correlations or validations of model results with measured air quality leave the value of these models in doubt.

INTRODUCTION

This is the first follow-up report on 15 of the Air Pollution Pilot Study Recommendations. Information for the report was collected through a questionnaire prepared by the United States, as pilot of the completed first air pollution pilot study.

The plan called for annual reporting to track progress of member nations with respect to seven of the 15 recommendations. Specifically, this first report concentrates on the status of Recommendations I, II, III, IV, V, VII, VIII, and XIV in cities with populations over 600,000. These Recommendations include general assessment of air pollution standard-setting, establishment of air quality monitoring systems and suitable systems for retrieval and storage of data, employment of recognized reference methods for monitoring, and institution of uniform procedures for conducting emissions inventories. The results of the first year's follow-up questionnaire, analyzed in this report, are intended to provide baseline information for comparison with improvements reported in response to future follow-up.

Responsiveness

Responses varied considerably among nations. A total of ten nations submitted completed questionnaires for all cities in the survey. Three nations submitted completed questionnaires for half of the survey

cities. Another cited "the unjustified amount of extra work" required for completion of questionnaires, but submitted publications from which it was possible to fill out a partial questionnaire for one city. One nation submitted a letter providing relevant information in lieu of responding to the questionnaire, because very low levels of pollution have called for little effort in the air pollution field and many of the questions were not felt applicable. Only one NATO nation did not respond at all to the follow-up survey.

The survey included 51 cities with populations over 600,000 and the capitals of the three nations having no cities over 600,000. At the time of report finalization, responses had been received for 44 of the 54 cities, as listed in Figure 1. When blank lines appear beside a city or nation in figures with this report, they indicate that no response was received from that city or nation for that question.

Populations and Areas of Reporting Cities

Figure 2 presents the populations and areas of reporting cities. These statistics are useful in assessing the relative magnitude or significance of various information (e.g., gross emissions, number of monitoring sites, refinement of control efforts). Differences in geographical approaches to air pollution control between nations result in considerable variety in the types of areas and populations for which responses were made. Some nations included only the highly urbanized areas within the political boundaries of a city. Others

Responses Received

- Canada
  - Montreal
  - Ottawa
  - Toronta
  - Vancouver
- Denmark
  - Copenhagen
- France
  - Marseille
  - Paris
- Germany (Fed. Rep.)
  - Cologne
  - Dortmund
  - Dusseldorf
  - Essen
  - Frankfurt
  - Hamburg
  - Munich
  - Stuttgart
- Greece
  - Athens
- Iceland
  - Reykjavik
- Italy
  - Genoa
  - Milan
  - Turin
- Luxembourg
  - Luxembourg City
- Netherlands
  - Amsterdam
- Norway
  - Oslo
- Portugal
  - Lisbon
- Turkey
  - Ankara
- United Kingdom
  - London
- United States
  - Baltimore
  - Boston
  - Chicago
  - Cleveland
  - Dallas
  - Detroit
  - District of Columbia
  - Houston
  - Indianapolis
  - Los Angeles
  - Memphis
  - Milwaukee
  - New York City
  - Philadelphia
  - St. Louis
  - San Antonio
  - San Diego
  - San Francisco

No Response

- Belgium
  - Brussels
- Italy
  - Naples
  - Palermo
  - Rome
- Netherlands
  - Rotterdam
- Turkey
  - Istanbul
- United Kingdom
  - Birmingham
  - Glasgow
  - Liverpool
  - Manchester

Figure 1. Survey Responses

FIGURE 2: REPORTED POPULATIONS AND AREAS

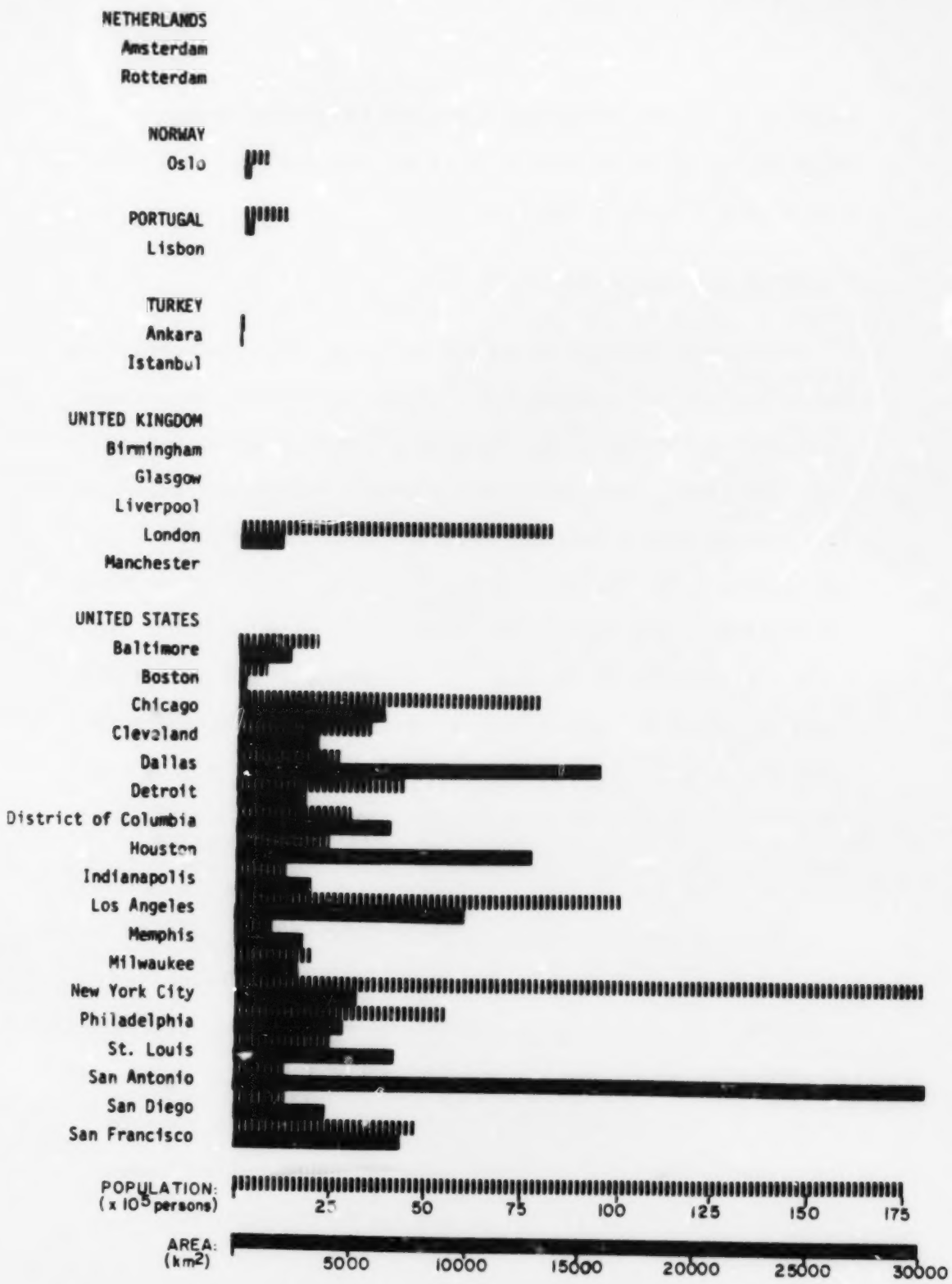

FIGURE 2: REPORTED POPULATIONS AND AREAS (continued)

reported for areas including suburbs and surrounding countryside, based on the air basin concept or an approach such as the Air Quality Control Region used in the U.S.

Standards and Control Approaches

Recommendation VIII of the Air Pollution Pilot Study encourages member nations to set ambient air quality standards or objectives using CCMS and World Health Organization (WHO) criteria to establish those standards in accordance with national priorities. One of the basic differences in the approaches and objectives of national air pollution programs involves ambient standards. Some nations place primary emphasis on the quality of ambient air, while others concentrate on standards set for specific categories of emission sources. One city reported a scheme in which desired ambient concentrations were set for various industrial sectors and emission control levels within those sectors adjusted to bring about the desired ambient concentrations.

This city was the only instance in which emission control levels were set within a single city for the purpose of achieving locally-set standards. This approach very closely approximates the CCMS-endorsed concept of relating emission controls required directly to desired ambient air quality in a cohesive air quality management system. The present survey did not investigate the relationship between emission control programs and ambient standards directly.

Figure 3 shows a need for considerable work in standard setting, since only five countries have established ambient air quality standards. Only two nations reported secondary (welfare-related) ambient standards. Five nations reported no standards at all. (Nations are checked in Figure 3 if they reported any type of ambient standard. When cities within single countries reported differing sets of local or regional standards, the total of unduplicated source categories for the whole country is presented.)

Compliance with specific ambient standards is often related to specific statistical techniques and monitoring schemes. Thus ambient standards are not necessarily directly comparable. Location of monitoring sites, time period of measurement, and method of analysis vary considerably from nation to nation. Monitoring sites were found to be either population-oriented, industry-oriented, or located on a grid system. The 24-hour average is accepted by most nations for total suspended particulates (TSP) and sulfur dioxide (SO_2), while the 8-hour average is used for carbon monoxide (CO). One nation, however, expresses its SO_2 standard in terms of the annual average and the 95th percentile values based on 1/2-hour, 1-hour, or 24-hour averages, while long-term standards are 24-hour or annual averages. Two nations reporting CO standards agreed on the average of eight hourly averages for the long-term standard but used 1/2-hour and 1-hour periods for the short-term standard. Only two nations reported standards for oxidants (O_x).

	Ambient Standards				Number of Source Standards
	TSP	SO_x	CO	O_x	
BELGIUM					
CANADA	X	X	X	X	9
DENMARK					13
FRANCE					4
GERMANY (FED. REP.)	X	X	X		50
GREECE					0
ICELAND					0
ITALY	X	X	X		0
LUXEMBOURG	X	X			0
NETHERLANDS					0
NORWAY					1
PORTUGAL					0
TURKEY					0
UNITED KINGDOM					60
UNITED STATES	X	X	X	X	13

Fig. 3. Nations Reporting Standards

AMBIENT MONITORING

Objectives

Recommendation II of the Air Pollution Pilot Study encouraged establishment of an effective air quality monitoring system, including measurement of meteorological parameters. The objectives of current monitoring systems were ranked to provide a reference point for evaluation of the effectiveness of systems. These rankings by cities were aggregated to remove slight differences within nations, and are presented in Fig. 4.

Two nations reported high priority for the objective of assessing compliance with ambient air quality standards and yet reported having no health-related standards. The five nations with ambient standards reported assessment of compliance as the first priority objective. Validation of dispersion models has a uniformly low priority. Other priorities are highly variable from country to country. Variations in rankings obtained in some countries indicates that these rankings do not necessarily represent official or legislated national objectives.

Instrumentation

Figure 5 shows the number of monitoring sites reported by each city and the degree of automation of these sites. All fourteen responding nations have monitoring sites. All but three of these nations reported having automated or semi-automated sites. Only three nations lacked meteorological instruments (see Fig. 6). Only three cities reported

	Assess Compliance with Standards	Health Research	Trend Analysis	Control Strategy Planning	Emergency Episode Operations	Dispersion Model Validation	(NATIONS REPORTING STANDARDS)
BELGIUM							
CANADA	1	5	4	2	3	6	*
DENMARK	2	3	1	5	-	4	
FRANCE	-	2	3	1	4	-	
GERMANY (FED. REP.)	1	5	4	3	2	6	*
GREECE	-	1	2	3	-	4	
ICELAND	-	-	-	-	-	-	
ITALY	1	5	2	4	3	6	*
LUXEMBOURG	1	4	2	3	5	6	*
NETHERLANDS							
NORWAY	2	3	1	4	6	5	
PORTUGAL	-	4	2	-	-	3	
TURKEY	6	3	2	1	5	4	
UNITED KINGDOM	-	4	2	1	-	-	
UNITED STATES	1	6	2	3	4	5	*

Legend:

- No Priority Given

Blanks Indicate No Response

Fig. 4. Monitoring Objectives

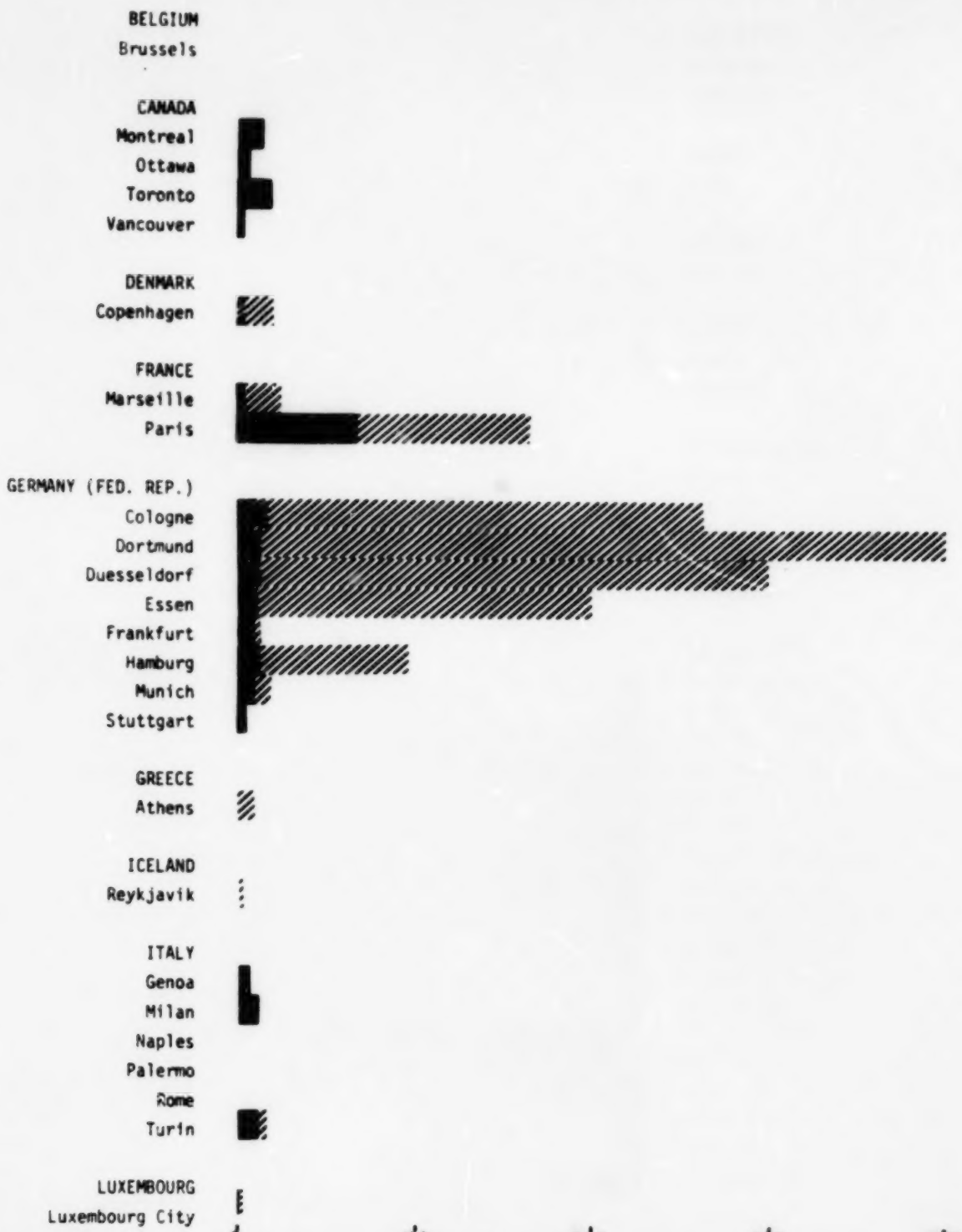

FIGURE 5: AUTOMATION OF MONITORING INSTRUMENTS

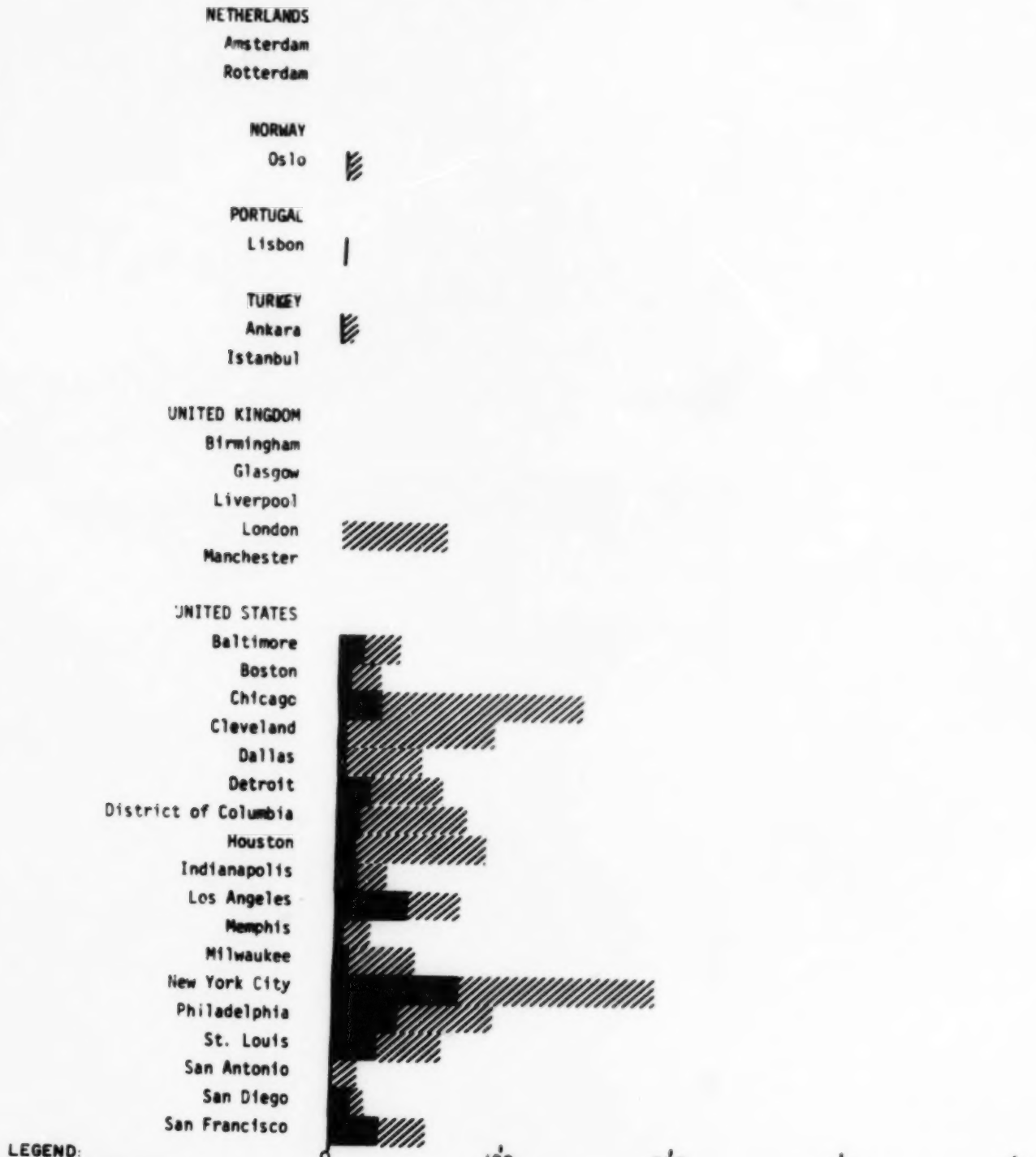

FIGURE 5: AUTOMATION OF MONITORING INSTRUMENTS (continued)

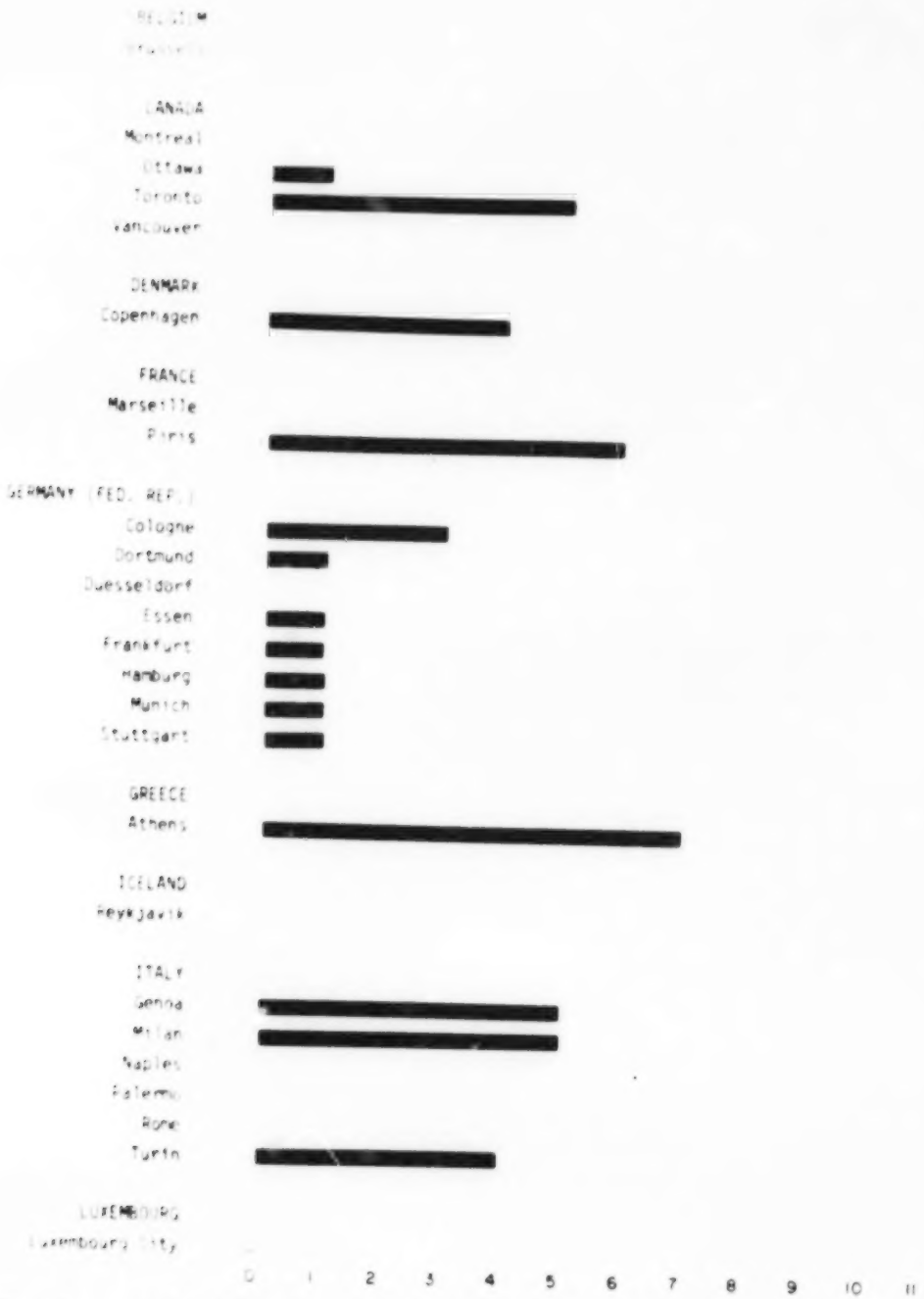

FIGURE 6: NUMBER OF SITES WITH WIND SPEED AND DIRECTION INSTRUMENTS

FIGURE 6: NUMBER OF SITES WITH WIND SPEED AND DIRECTION INSTRUMENTS (continued)

no automatic instruments, and nine cities reported at least half of their instruments automated. Basic differences in monitoring techniques and strategies result in wide variations of the number of monitoring sites in cities. Several cities employ mobile monitoring units heavily and consider each location sampled to be an individual site. These sites are sampled as infrequently as every two weeks. Some arrangements include as many as four monitors distributed vertically on a tall structure. Since these variations are know to exist, few general conclusions can be drawn.

Handling of Ambient Monitoring Data

Recommendation IV calls for systems for storage and retrieval of monitoring data such as those employed by the WHO. The efficiency of data handling techniques used by reporting cities can be tracked by questions dealing with telemetering of data and automation of data handling. The responses to these questions have been summarized in Fig. 7. Responses varied considerably among the cities of each nation. Fifteen cities telemeterd at least half of the data collected to a central facility. Twenty-one cities reported that some data are telemetered.

Only three cities reported totally computerized data handling while 21 reported at least 50% of the data are handled manually. Twenty-seven cities reported some automation of handling of monitoring data.

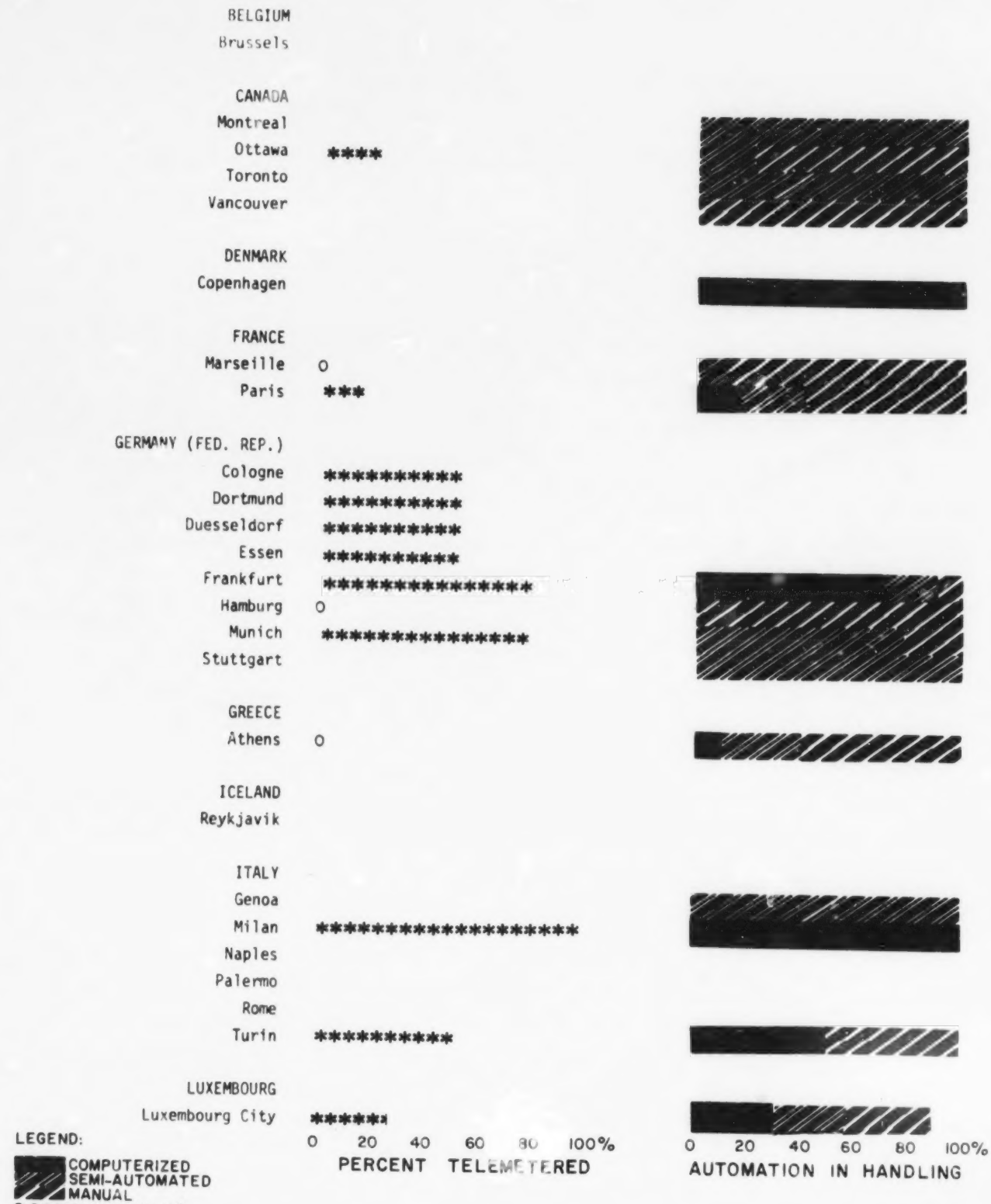

FIGURE 7: MONITORING DATA TECHNIQUES

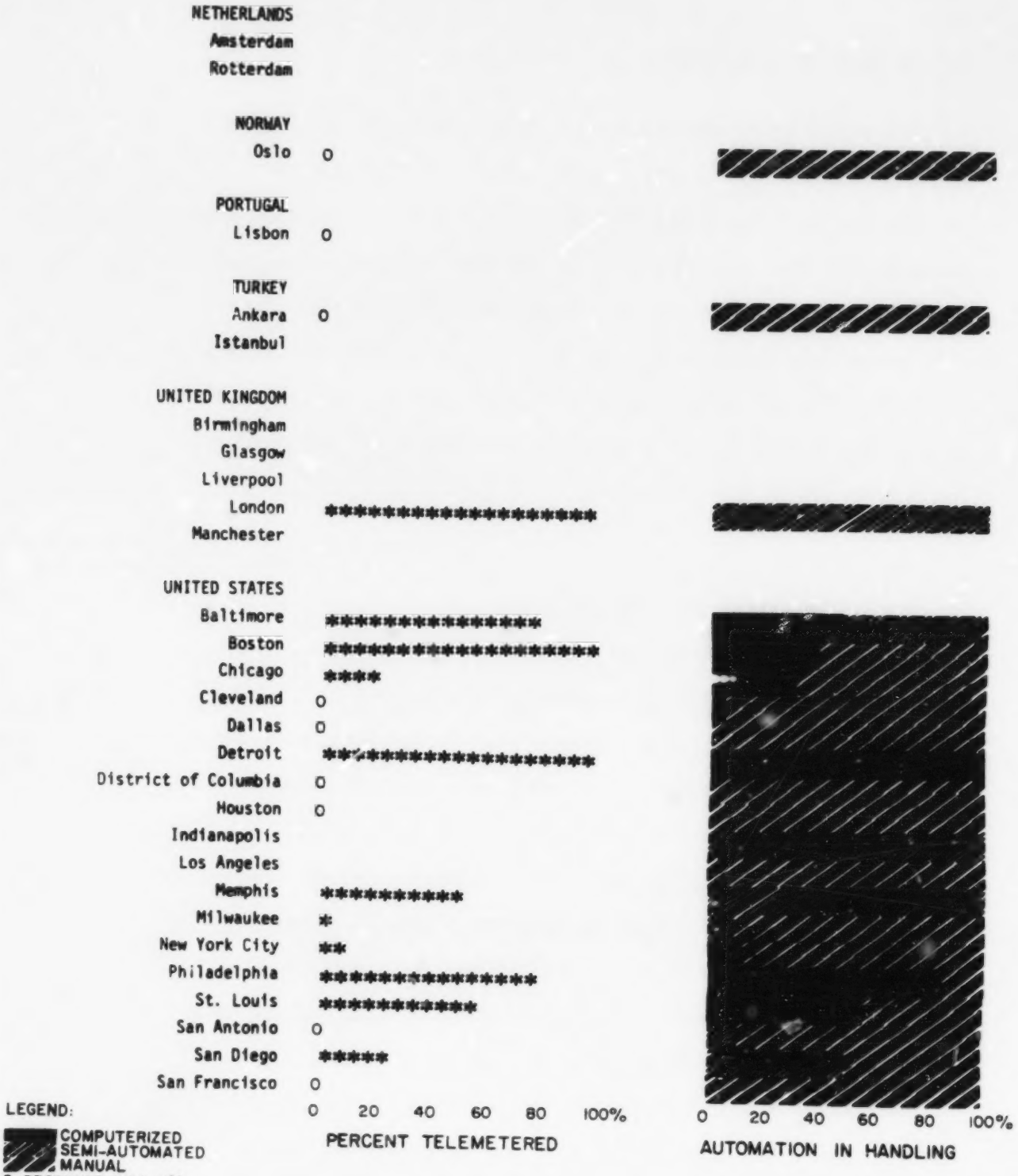

FIGURE 7: MONITORING DATA TECHNIQUES (continued)

Ambient Monitoring Statistics

The reporting of ambient monitoring statistics in the responses was quite limited. Only three nations with a standard for TSP reported monitoring data for that pollutant. Only four nations with standards for SO_2 reported statistics for SO_2. Of the four nations reporting statistics for CO, only three reported standards. Finally, only two nations reported data for oxidants. They both have standards. It is evident that the monitoring statistics reported are sufficient only to assess the success of nations in meeting their own standards and not for making any comparisons.

For TSP, the short-term (24-hour) standards were exceeded in 18 cities. Ten cities exceeded their standards for SO_2, three in one nation, four in another, two in one, and one in the last (see Figure 8). In CO monitoring, reporting cities in one nation did not exceed the short-term (1-hour) standard, while the two cities reporting in another nation had maximum values exceeding the national standard, and in a third nation ten of 17 cities reporting statistics had maximum 1-hour values exceeding the national standard. Four of these ten cities also exceeded the national standard on the second highest reading. Monitoring data for oxidants were not given for the same cities that reported standards in one nation. In the other nation with standards for oxidants, all but one city exceeded the national standard with the maximum 1-hour average. Four cities, however, were below the standard with the second highest reading.

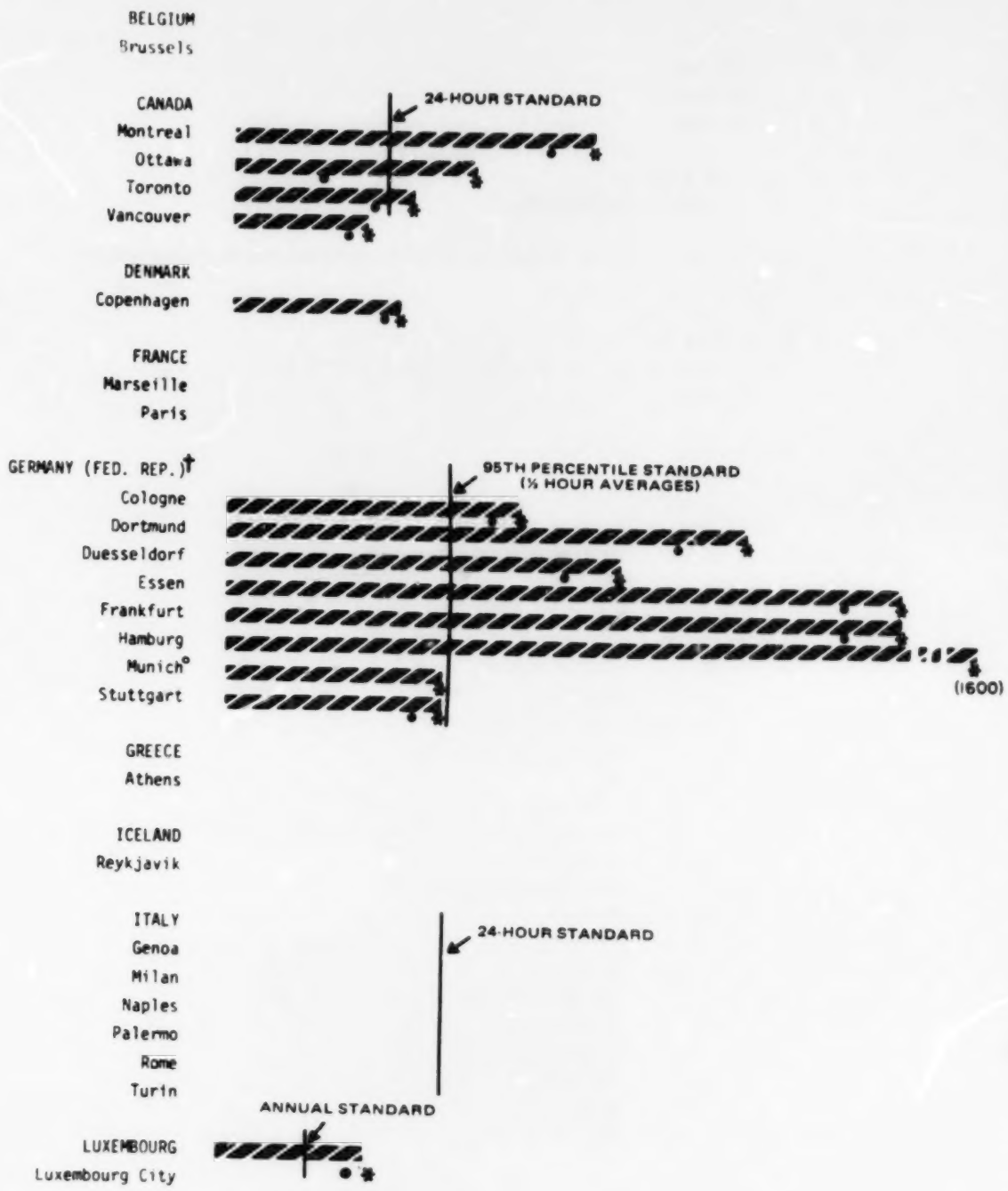

FIGURE 8: SO_2 MONITORING DATA COMPARED TO 24-HOUR STANDARD

FIGURE 8: SO_2 MONITORING DATA COMPARED TO 24-HOUR STANDARD (continued)

It is not very enlightening to compare standards or monitoring data between nations when the time intervals are not the same. Average values taken over a 24-hour period are expected to be different from those taken over a 1-hour period. In order to compare values between nations, it is recommended that they be expressed in the same units, for the same time interval, and, to insure accuracy, measured and analyzed in the same manner.

ANALYSIS OF AMBIENT AIR QUALITY TRENDS

One point of Recommendation XIV indicates the need for international cooperation to accomplish review of on-going air quality assessment studies. Figure 9 has been prepared to show the period of monitoring used in trend analysis and the latest year for which monitoring data are available. Figure 10 Summarizes the available trends by pollutant. In responses to questions related to this review, a total of 70 analyses of ambient air quality trends were reported. There were seven responding cities with no trend analyses reported and an equal number reporting analyses for only a single pollutant. The trend analyses were predominantly for SO_2 and TSP, but some analyses of trends for carbon monoxide (CO), oxidants (O_x), nitrogen oxides (NO_x) and fluorides (F) were also available. More than half of the analyses were based on monitoring data exclusively from years prior to 1972 and several analyses were apparently based on data from just one year. The average length of monitoring period over which analysis had been performed was eight years. The availability of more recent data in a number of cities indicates that more cities are developing data bases that will permit increased trend analysis. Increased emphasis on trends would be in line with fairly high priorities given to trend analysis by some nations in ranking objectives for the monitoring program.

Forty-nine cases of improving air quality (decreasing ambient concentration) and 18 cases of stable air quality were reported; there were two reported cases of quality declining over the entire analysis period (Figure 10). As shown in the figure, one city did report concentrations of TSP decreasing for part of the analysis period and then increasing. The pollutant for which these analyses showed the most favorable progress was TSP (20 decreasing, 4 stable). SO_2 trends are not quite as positive (23 decreasing, 8 stable).

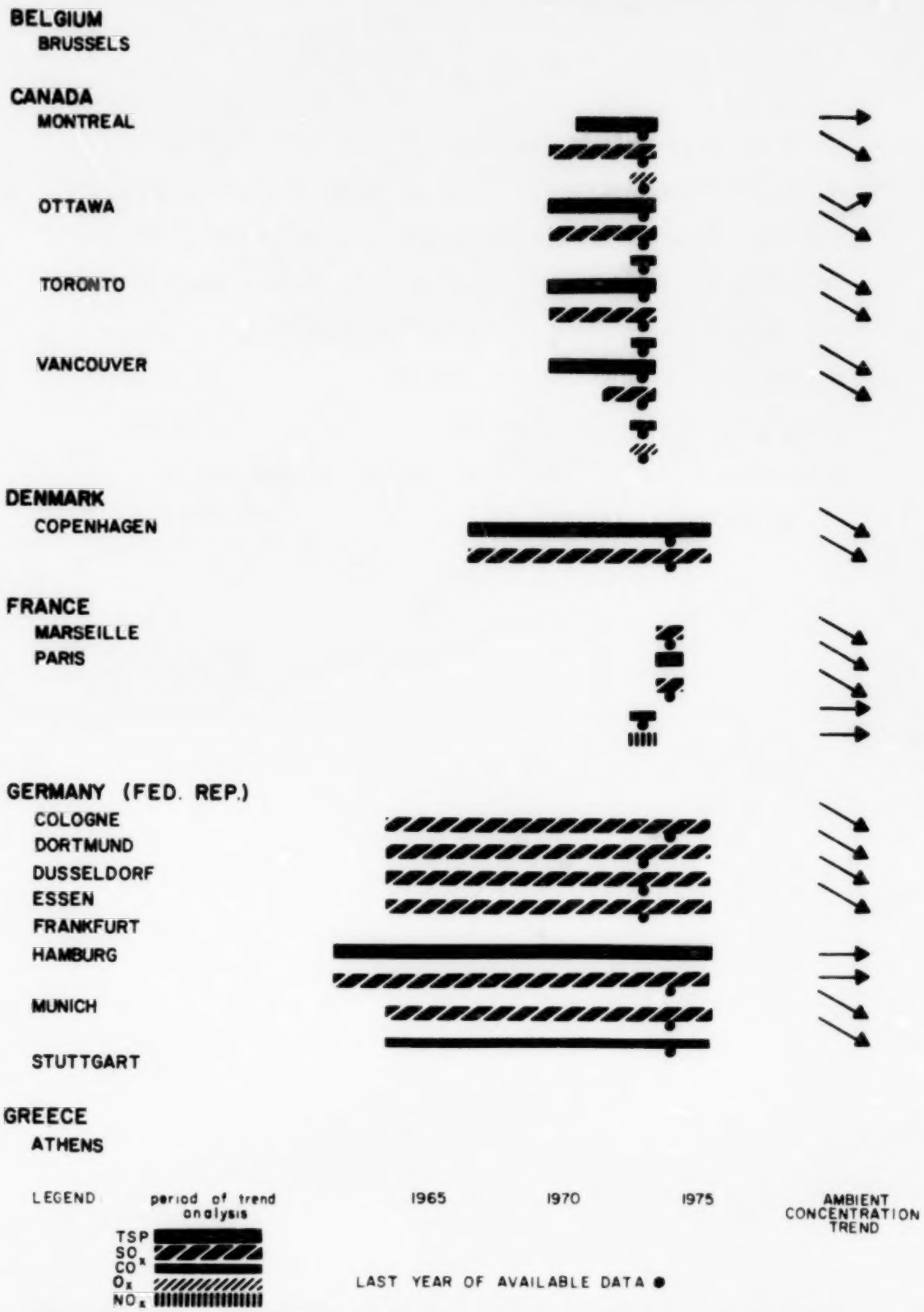

FIGURE 9: AMBIENT AIR QUALITY TREND ANALYSIS

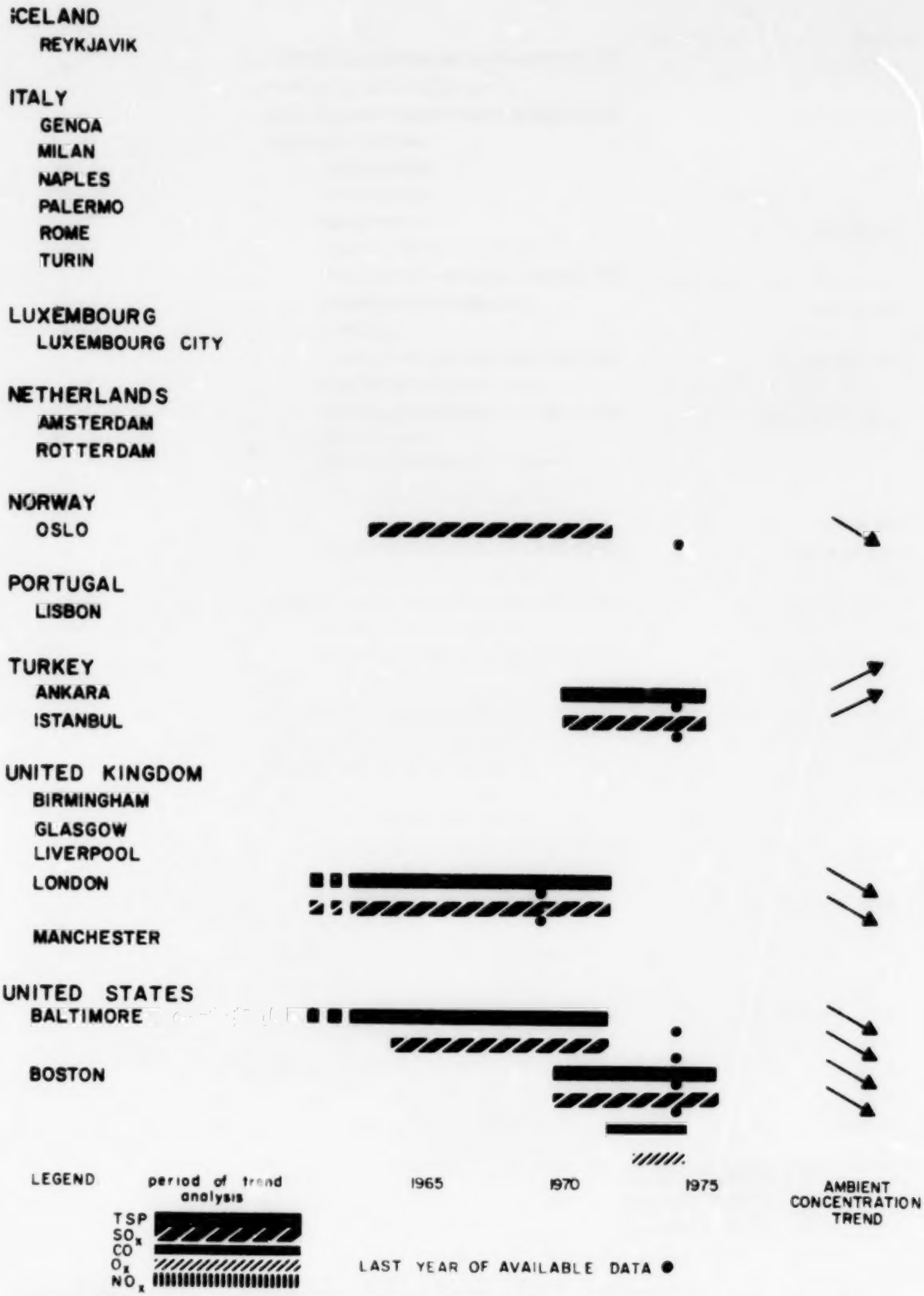

FIGURE 9: AMBIENT AIR QUALITY TREND ANALYSIS (continued)

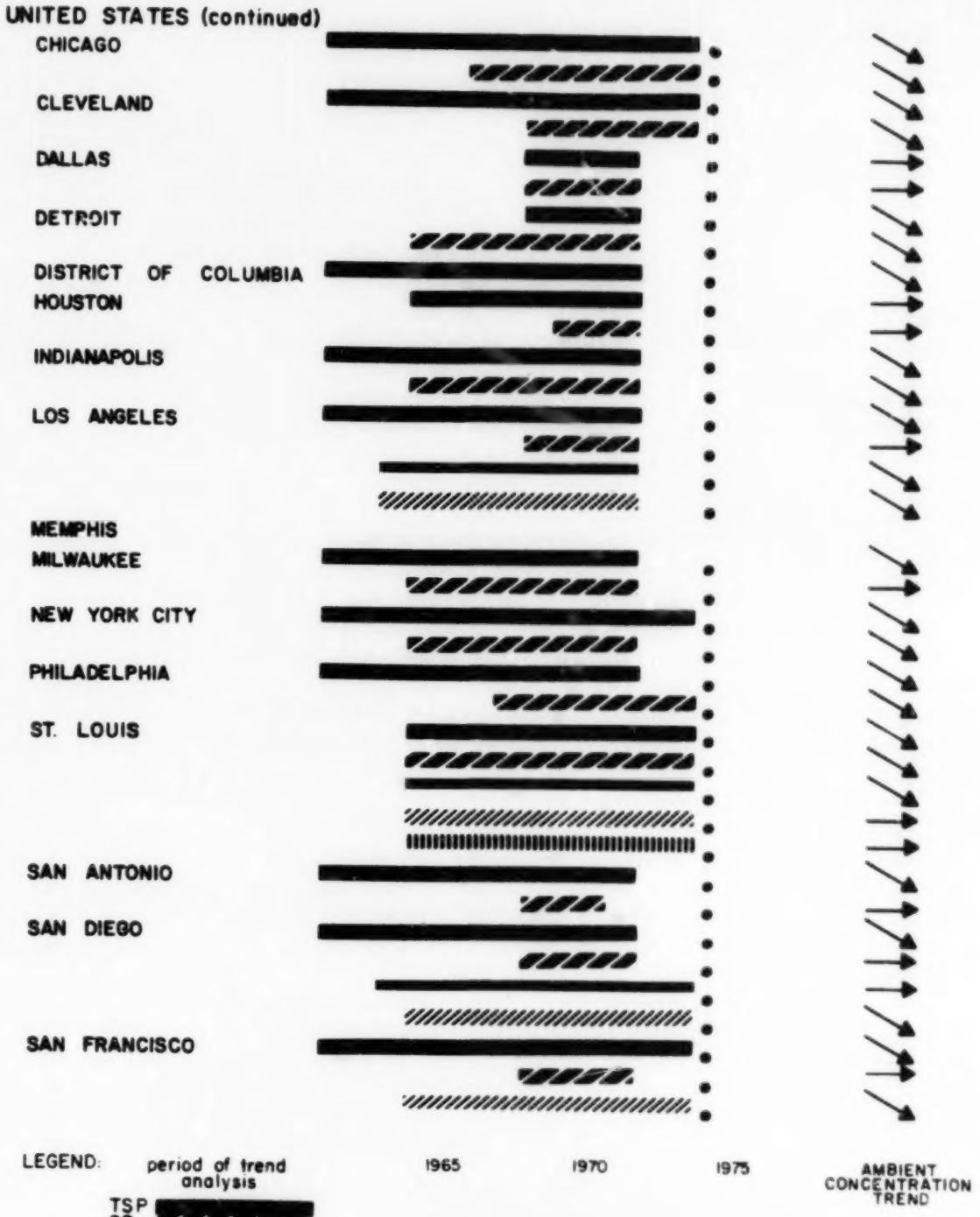

FIGURE 9: AMBIENT AIR QUALITY TREND ANALYSIS (continued)

	→	↘	↘↗	↗
TSP	4	20	1	1
SO_x	8	23		1
CO	2	3		
O_x	1	3		
NO_x	2			

→ Stable Air Quality

↘ Decreasing Ambient Concentrations

↘↗ Decreasing then Increasing

↗ Increasing

Fig. 10. Summary of Air Quality Trends

ATMOSPHERIC DISPERSION MODELING

Recommendations VII and XIV specify air quality modeling as part of prediction of future ambient concentrations. Figure 11 summarizes the modeling efforts reported in this survey. Forty-seven individual models were reported, all but nine being for TSP or SO_2. Twelve cities had no models, and 14 had only one pollutant modeled. Most models (36) were Gaussian rather than numerical (14). All but two of the TSP models were Gaussian, all O_x models were numerical, and SO_2 and CO models were mixed. Three-quarters of the models had planning as one of their purposes, eleven were also used for regulatory purposes, and only five for research.

Except for large groups of TSP and SO_2 models, unreported correlations or validations of model results with measured air quality leave the value of these models in doubt. Lack of information on the specific nature, extent and success of their use permits few conclusions to be drawn about the application of the various models in future control efforts.

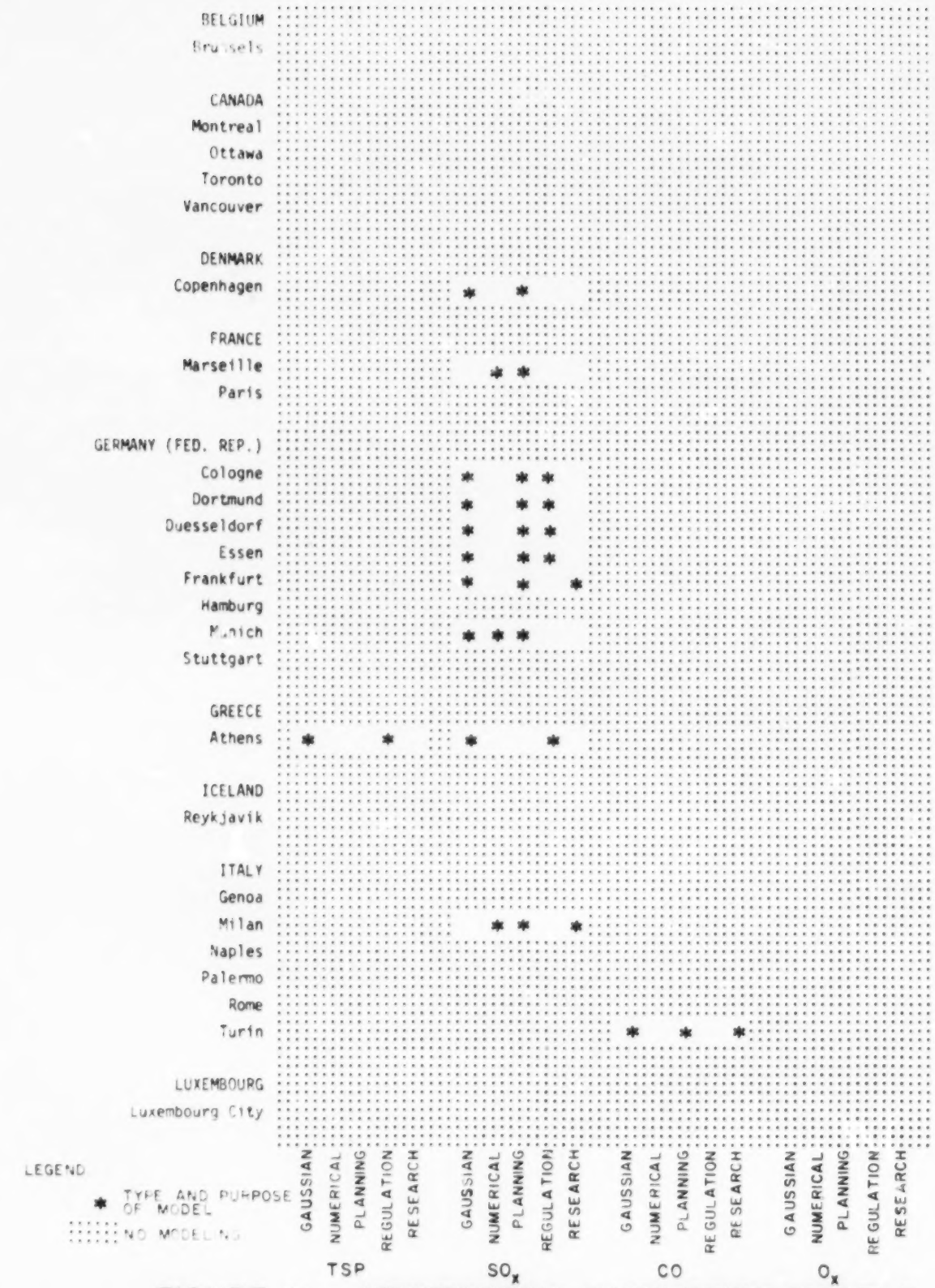

FIGURE 11: ATMOSPHERIC DISPERSION MODELS

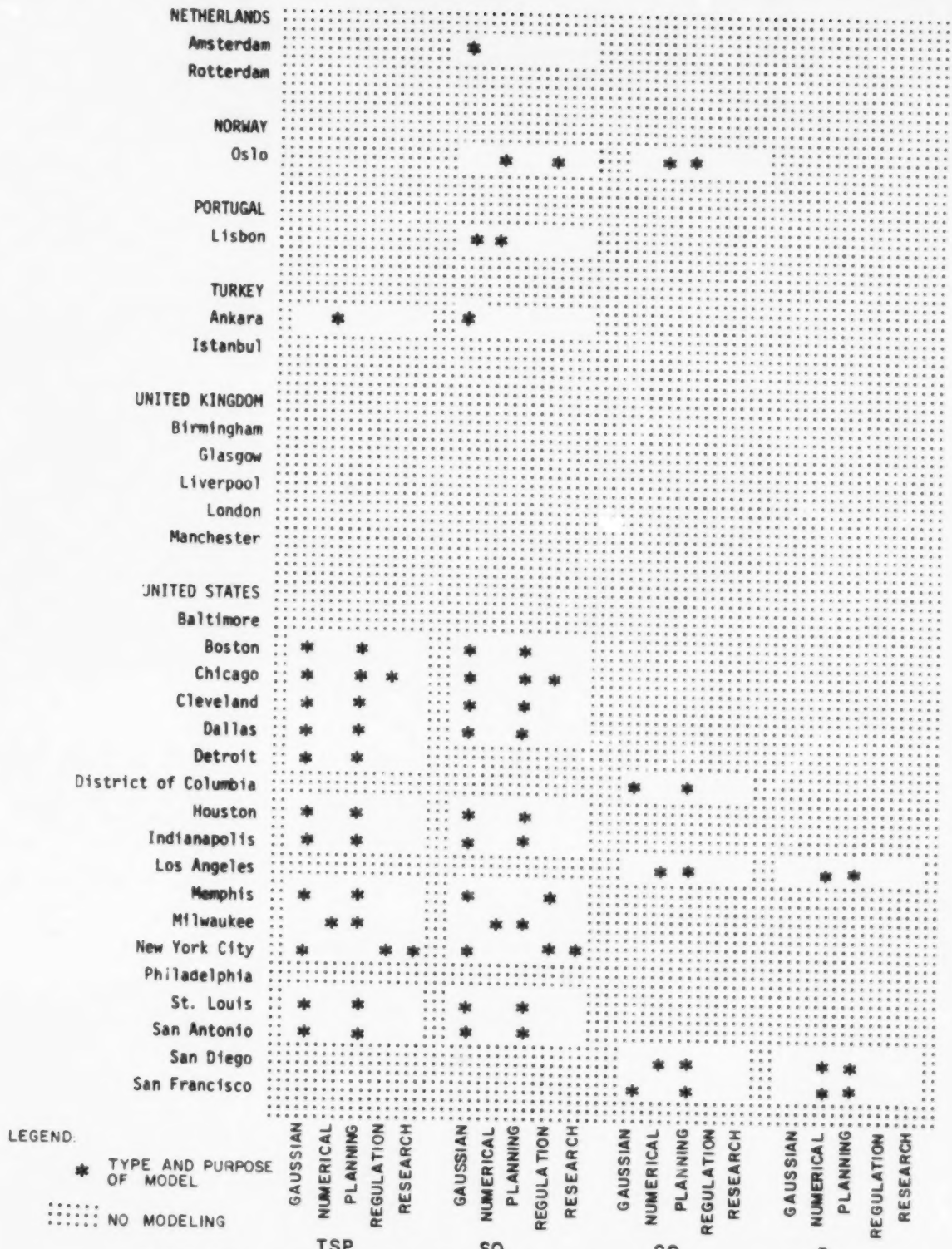

FIGURE II: ATMOSPHERIC DISPERSION MODELS (continued)

ACTIVITIES OF NATIONAL, REGIONAL, AND LOCAL AUTHORITIES

Figure 12 provides an overview of the divison of responsibility and activity in air pollution control in North Atlantic Council countries. It is based on the responses to various questions related to standards monitoring, modeling, and auto surveillance for emission factor development. As Figure 12 shows, in the area of monitoring, national or federal responsibility predominates, although in some nations it is shared with regional and/or local authorities. In one nation, the monitoring network is operated by a privately owned organization for the national government. Four of the five countries with health-related standards develop and apply them at the national level. One country has both regional and local standards, although the responsibility for standard-setting was not clear.

	Standard-Setting	Monitoring	Modeling	Auto Surveillance
BELGIUM				
CANADA	R,L	N,R,R/L,L	-	N
DENMARK	-	N*	-	R
FRANCE	-	N	N	N,R
GERMANY (FED. REP.)	N	N,R	R	-
GREECE	-	N	N	-
ICELAND				
ITALY	N	R	L,*	-
LUXEMBOURG	N	N	-	-
NETHERLANDS	-	-	N	-
NORWAY	-	L	N	-
PORTUGAL	-	N	N	-
TURKEY	-	N	N	-
UNITED KINGDOM	-	N,L	-	-
UNITED STATES	N	N,R,L	N,R,L	N

N = National/Federal
R = Regional/State/Provincial
L = Local/Municipal
* = Privately Operated
- = No Activity Reported

Fig. 12. Activities of National, Regional and Local Authorities

DATA AVAILABILITY

Recommendation IV of the Air Pollution Pilot Study encourages establishment of systems for monitoring data storage and retrieval as essential to successful control efforts. Figure 13 summarizes the availability of various data elements by nation. Data were considered "available" if they were reported to exist for one or more cities in a nation.

Some nations had relatively uniform sets of data for all cities, while some nations had considerable internal variety in pollutants and time periods. Most cities had data on SO_2 and TSP (or other equivalent/related pollutants such as soot, dust, or smoke). Monitoring of CO was also fairly common. A total of nine nations had data available on at least one pollutant, and six had data on three or more. Data on emissions was less common and more uniform within nations than ambient air quality data. Only five nations reported having emissions data available. Four of these nations also have sets of emission factors available for possible synthesis of emission inventories.

There were four nations (seven cities) listing dates for which data are available without supplying the data itself. Since all reporting cities have monitoring programs, this indicates that accessibility of existing data within a reasonable time and in a variety of

forms may be a problem. Reallocation of some resources from data collection to processing and accessing might be advisable in these cases.

	Point Sources	Stationary Area Sources	Mobile Area Sources	Line Sources	Emission Factors	Ambient Air Quality
BELGIUM						
CANADA			ALL			TSP, SO_2, CO, O_x
DENMARK	SO_2	SO_2			X	TSP, SO_2
FRANCE						TSP, SO_2, CO
GERMANY (FED. REP.)	ALL	ALL	ALL			TSP, SO_2, CO, O_x
GREECE	ALL	ALL	ALL	X	X	
ICELAND						TSP, SO_2, CO, O_x
ITALY						TSP, SO_2, CO
LUXEMBOURG						TSP, SO_2
NETHERLANDS						
NORWAY	SO_2, NO_x	SO_2, NO_x	ALL		X	TSP, SO_2, CO
PORTUGAL						O_3
TURKEY		ALL	ALL			
UNITED KINGDOM						TSP, SO_2
UNITED STATES	ALL	ALL	ALL		X	TSP, SO_2, CO, O_x

ALL = TSP, SO_2, CO, HC, NO_x

Fig. 13. Data Availability